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Self photo-pumped neon-like and nickel-like X-ray lasers

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A new X-ray laser mechanism is presented which uses radiation trapping of the strongest 3d $^1P_1 \rightarrow$ 2p $^1S_0$ neon-like resonance line in an optically thick plasma to create an intense radiation field which radiatively drives population from the neon-like ground state to the 3d $^1P_1$ state, which then lases to the 3p $^1P_1$ and 3p $^3P_1$ states. Collisional mixing of the 3p states with nearby 3s and 3d states depopulates the lower laser states. Modeling is presented for this mechanism in neon-like argon. Strong gain is predicted on the two 3d $\rightarrow$ 3p transitions at 451 Å and 465 Å, the first of which has been observed in recent X-ray laser experiments using an argon gas puff. The 3d $^1P_1 \rightarrow$ 3p $^1P_1$ line has also been observed at 601 Å and 300 Å, respectively, in X-ray laser experiments recently done on sulfur targets using the prepulse technique and on titanium targets driven by a nanosecond pulse followed by a picosecond pulse. This pumping mechanism also enhances the population of the 3p $^1S_0$ state and the gain of the two 3p $\rightarrow$ 3s, J = 0 $\rightarrow$ 1 transitions which are at 431 and 469 Å in argon. This generic scheme can also work in other ionization stages. In nickel-like ions, the analogous process of lasing on the 4f $\rightarrow$ 4d transitions due to photopumping by the strong 4f $\rightarrow$ 3d lines will be discussed.

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